Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

Summer Examinations, 2011/2012

Exam Code(s)	4IF
Exam(s)	4th Year Examination in BSc in IT
Module Code(s)	CT421
Module(s)	Artificial Intelligence
Repeat Paper	No
External Examiner(s)	Professor M. O'Boyle
Internal Examiner(s)	Professor G. Lyons *Dr M. Madden *Dr C. Mulvihill *Dr F. S. Smith
Instructions:	Attempt two questions from Section A and exactly one question from each of Sections B and C. Use a separate answer book for each section.
Duration	**3 hours**
No. of Pages	5
Department(s)	Information Technology

Section A

1)

a) Write the following Prolog predicates:

i) square(X,Y). where Y is the square of X, e.g.:
:-square(5,Y).
Y = 25
Explain how your predicate would respond to the following query:
:-square(A,36).

(5 marks)

ii) averagelist(List,Average). where Average is the average of the elements in the list List. e.g.:
:-averagelist([1,2,3],X).
X = 2

(11 marks)

b) Explain what is meant by the "Closed World Assumption" in Prolog, pay particular attention to its advantages and disadvantages.

(9 marks)

2)

Write Prolog predicates to do the following:

a) lastelement(L1, Last). Where Last is the last element in the list L1
example:
the query:
lastelement([1,3,5], X).
X = 5

(12 marks)

b) subset(L1,L2). where list L1 is a subset of list L2, e.g.:
:-subset([a,b],[c,b,a]).
gives the result
yes
(Hint: use the member predicate)

(13 marks)

3)

a) Describe the principles behind Model-Based-Diagnosis (MBD).

(5 marks)

b) Explain why in MBD multiple faults are more complex to identify than single faults. How does GDE handle this complexity?

(5 marks)

c) Describe some of the limitations of the original GDE that were overcome by later developments.

(5 marks)

d) Using QSIM and given the following constraints (which represent the motion of a ball being thrown in the air):

DERIV(x , v)
DERIV(v , a)
a = g < 0

and the quantity spaces:
{ -∞, 0, ∞} for v
{ 0, top } for x

If the initial state is:
$QS(x,t_1)=<top,std>$
$QS(v,t_1)=<0,dec>$
$QS(a,t_1)=<g,std>$

What are the possible next states? (Show your workings)

Rule-id	$QS(v,t_i)$	$QS(v,t_i,t_{i+1})$
P1	$<l_i,std>$	$<l_i,std>$
P2	$<l_i,std>$	$<(l_i,l_{i+1}),inc>$
P3	$<l_i,std>$	$<(l_{i-1},l_i),dec>$
P4	$<l_i,inc>$	$<(l_i,l_{i+1}),inc>$
P5	$<(l_i,l_{i+1}),inc>$	$<(l_i,l_{i+1}),inc>$
P6	$<l_i,dec>$	$<(l_{i-1},l_i),dec>$
P7	$<(l_i,l_{i+1}),dec>$	$<(l_i,l_{i+1}),dec>$

(10 marks)

Section B

4)

(a) Provide a definition of Machine Learning. Starting from this definition, identify the commonality and distinctions between supervised, unsupervised and semi-supervised learning tasks. As part of your answer, provide examples of all three tasks (one each) and for each task identify a machine learning technique that would be appropriate for tackling it. (10 marks)

(b) Explain in detail how the ID3 algorithm operates to induce a decision tree from examples. (5 marks)

(c) A civil engineer has sent you the following email message. Prepare a detailed reply.
"As I mentioned when we were having coffee yesterday, I am working on new 'recipes' for concrete. I would like to try using the k-Nearest Neighbours algorithm build predictive models for two questions: whether the recipe is ***successful*** *or not, and what the final* ***strength*** *of the concrete is (this is a numeric quantity). Can it be used for both of these? Also, I am aware that there are different ways of measuring "nearness", but I don't know which to use. Can you provide a description of four such measures, and give me some advice on how I should decide which one to use?"* (10 marks)

5)

(a) Explain, with examples, the distinction between **conditional** independence and **absolute** independence. How are each of these represented in a Bayesian network? (5 marks)

(b) Bayesian networks can be used for both data exploration and classification. Explain this. (5 marks)

(c) In the context of Linear Support Vector Machines, what are the support vectors? Describe in detail how they are found. (5 marks)

(d) A company is working on a students' social media site with short messages, and wishes to automatically identify messages that are junk. They have the following small set of messages that are junk and good:

Junk:	*Good:*
"click this link"	"exams start tomorrow"
"secret news here"	"good luck in exams"
"secret weight link"	"good start"
	"news meeting tomorrow"

Using a Naïve Bayes classifier, compute the probability of the following two messages being junk: (1) "secret news link"; (2) "exams news". Show all steps in your computation and explain any assumptions you make. (10 marks)

Section C

6)

(a) Explain what is meant by the term 'steganography'. (6 marks)
(b) Sketch how two intelligent agents could engage in covert full-duplex information exchange using game decision trees as steganographic cover media (8 marks)
(c) "An untrustworthy agent could misdirect" - develop a scenario for this in the context of an agent that assists in simple IT-based administrative activity (11 marks)

7)

(a) Develop a definite clause grammar in Prolog that encompasses the non-terminals for sentence 's', noun phrase 'np', verb phrase 'vp', verb 'v', noun 'n', determiner 'det', and at least the terminals 'a', 'the', 'greets', 'man', 'woman' (8 marks)
(b) Show that in the grammar that you developed in (a) above the additional rules np --> pro, pro --> [she], pro --> [her] are not enough to yield an extended grammar that accounts for subject and object categories and suggest any one possible solution to this problem (6 marks)
(c) Discuss how a parse tree can be generated in Prolog through the use of extra arguments that keep track of the formulated grammatical structure in definite clause grammar rules (11 marks)